MATCHING QUADRUPOLE APERTURE INCREASE??

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A. Maschke has pointed out that the aperture limitation in the main ring is at the matching quadrupoles for the long straight section. Since these magnets do not cost a significant fraction of the cost of the bending magnets, it would seem that either the quadrupole aperture should be increased, or the bending magnet aperture decreased. This argument is complicated by the fact that the aperture loss at the quadrupoles is in the extreme corners. It is unlikely that useful beam will ever occupy this space. In addition, the vacuum chamber must have rounded corners so that at least a part of this space is lost in any case. T. Collins has calculated the stresses in the vacuum chamber wall and found that the chamber can be much more nearly square than the elliptical chamber shown on sketches, but some rounding is needed.

The main significance of this aperture loss is that it is difficult to protect the poles of the matching quadrupoles with beam scrapers without further reducing the aperture. The particles which might strike these poles are ones which have scattered from the beam scrapers or from one of the septa. This clearly needs further thought and computation.

A. Garren has re-computed the long straight section with quadrupoles having a lower value of the gradient, corresponding to a slightly increased aperture. The actual aperture used was selected by assuming that the quadrupole magnets had two more turns per pole (19 instead of 17), giving a gradient lower by the ratio of 17/19, and an aperture larger (the xy product)

in the inverse of this ratio. This slight increase in aperture, barely more than 10%, necessitated a decrease in the length of the field-free straight section of 1.0 meters. A further increase in aperture would decrease the field-free straight by an amount which would be roughly proportional to that found in this computation. While this loss may not be significant, the length of the matching quadrupoles is increasing rapidly as their aperture is increased, and the magnet fabrication cost will increase as well.

The magnitude of the aperture limitation caused by the quadrupoles may be seen by mapping the magnet apertures onto one another. Quite arbitrarily, I chose to map the apertures of the bending magnets, cell quadrupoles, and matching quadrupoles all onto a map with $\beta_x = \beta_y = 100$. I selected, from the printout of the beta functions corresponding to the "March lattice," the largest values found in each type of magnet. For the quadrupoles, I selected the largest value of the product of the beta functions. The figure is this map, drawn actual size.